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Koshio

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(54) **TIRE WITH TREAD HAVING BLOCKS HAVING CUTOUT PORTIONS**

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CPC ***B60C 11/11*** (2013.01); ***B60C 11/125*** (2013.04); ***B60C 11/1369*** (2013.04); *B60C 11/12* (2013.01); *B60C 2011/0346* (2013.04); *B60C 2011/1213* (2013.04); *B60C 2011/133* (2013.04); *B60C 2200/06* (2013.04); *B60C 2200/14* (2013.04)

(58) **Field of Classification Search**
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USPC .... 152/209.15, 209.18, 209.21, DIG. 3
See application file for complete search history.

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(57) **ABSTRACT**

Provision of a tire with enhanced wet weather performance while maintaining resistance to uneven wear performance without entailing an increase in the tread rubber volume. A center block row (**30**) is formed extending along the tire circumferential direction U in a tread section (**18**). Blocks (**33**) configuring the center block row (**30**) when viewed from the tread face side are formed with long sides (**34**H) adjacent to respective main grooves (**20**L), (**20**R) and short sides (**34S1**), (**34S2**). Cutout portions (**21**) are formed in the blocks (**33**) on the sides of the long sides (**34**H).

11 Claims, 7 Drawing Sheets

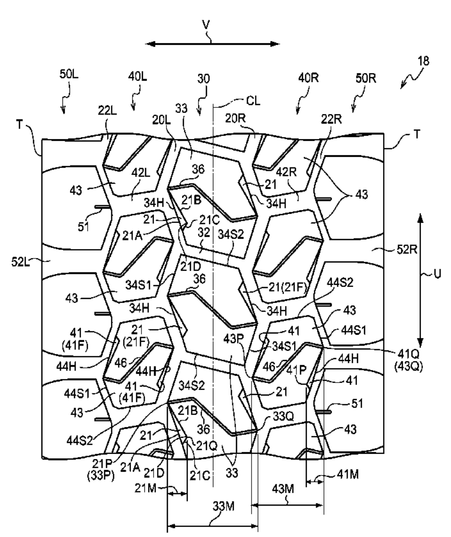

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FIG.1

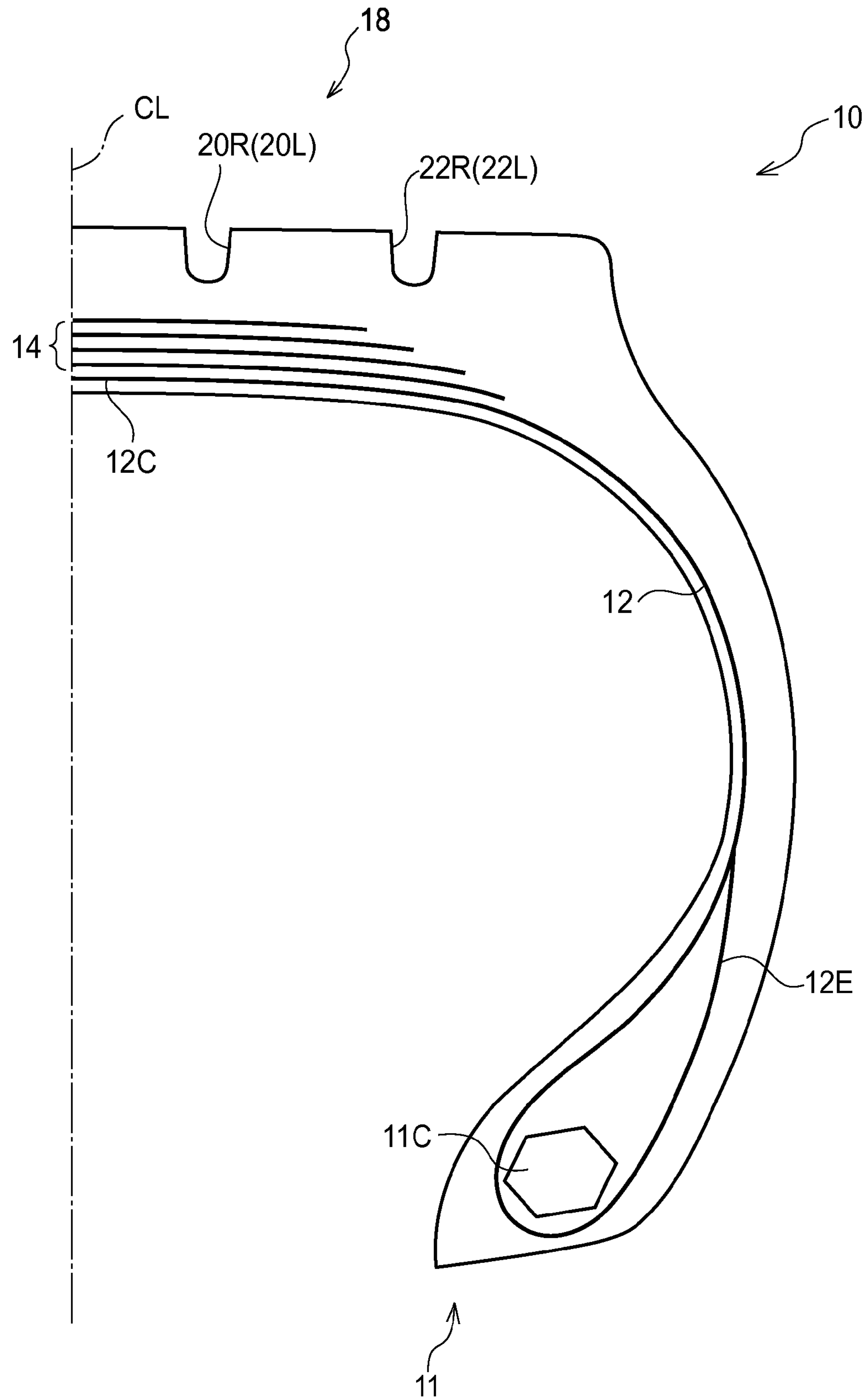
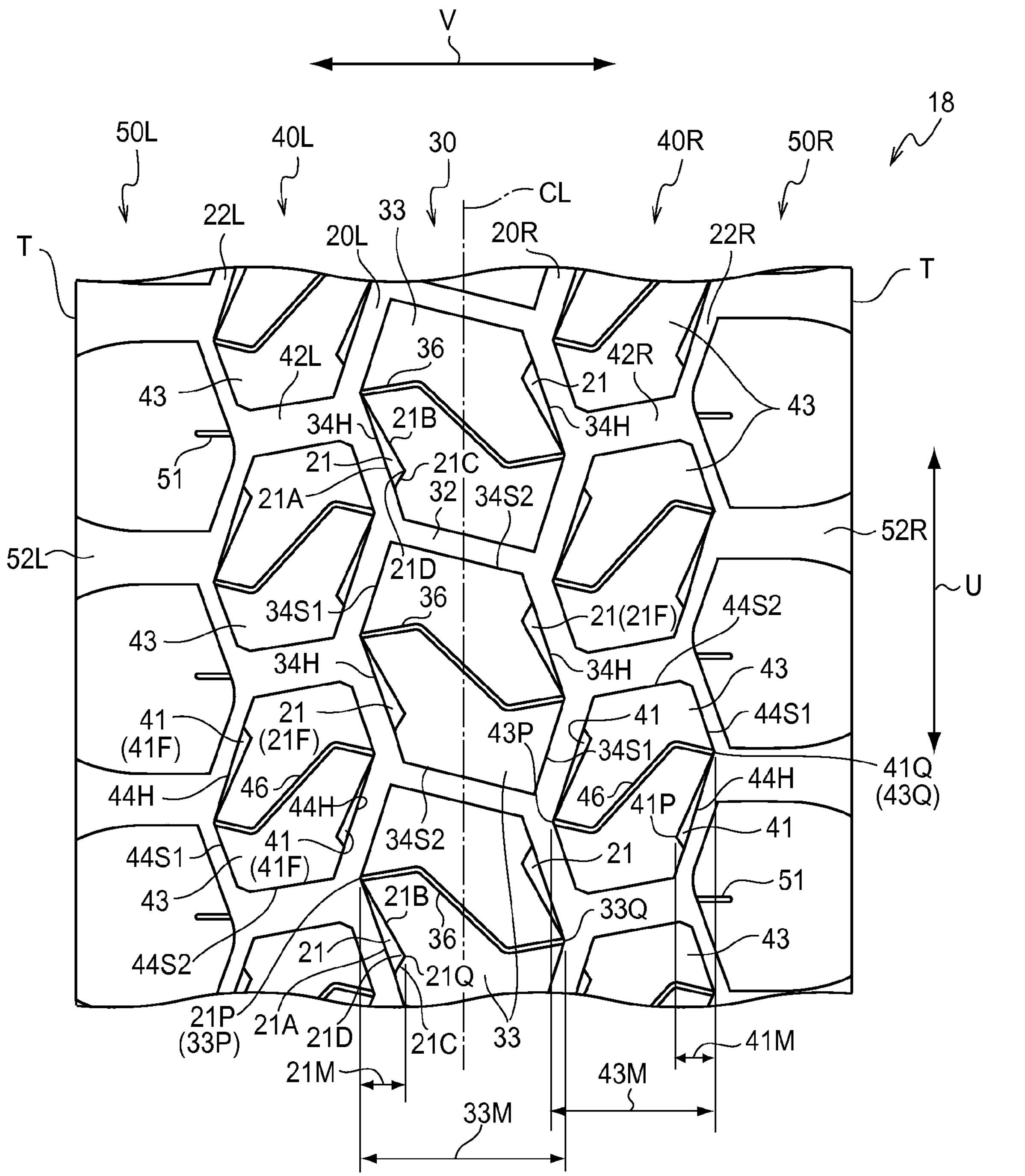


FIG.2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30
40R
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CL
22L
33
20L
20R
22R
T
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42L
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43
21
43
34H
21B
34H
51
21
21C
21A
32
34S2
52R
52L
21D
U
34S1
36
21(21F)
44S2
43
34H
34H
43
21
41
41
(41F)
(21F)
43P
34S1
44S1
41Q
(43Q)
44H
46
44H
46
41P
44H
41
34S2
41
(41F)
44S1
21
51
43
21B
33Q
36
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21M
33M

FIG.3

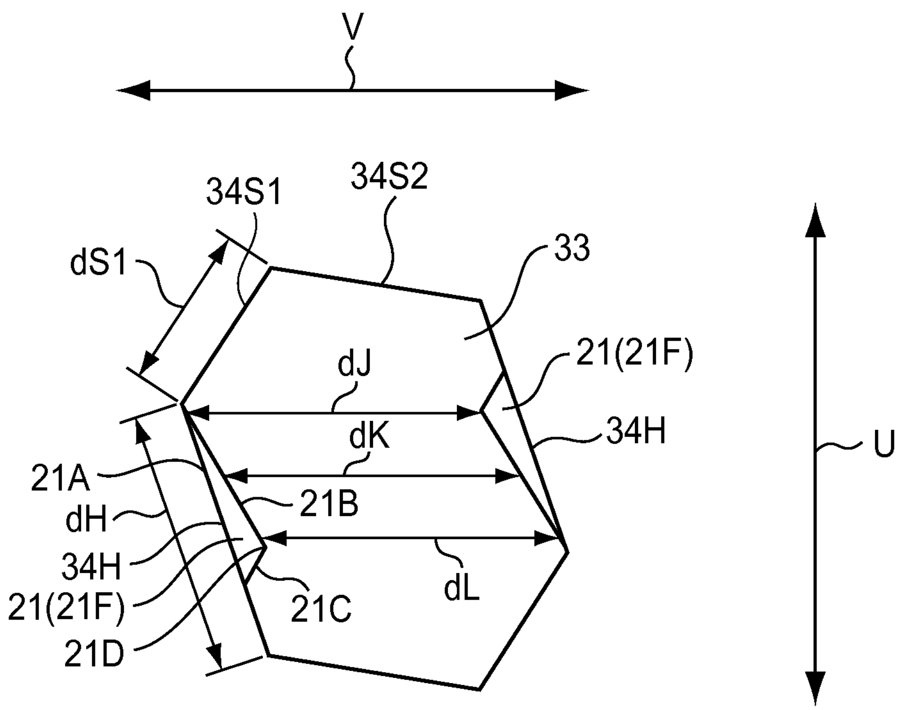

V
34S1
34S2
dS1
33
dJ
21(21F)
dK
34H
U
21A
21B
dH
34H
21(21F)
21C
dL
21D

FIG.4A

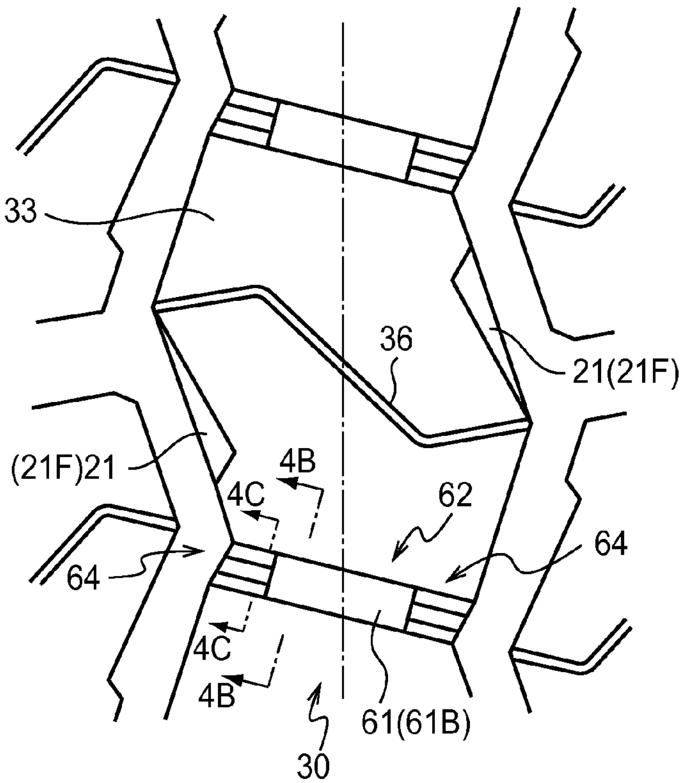


FIG.4B

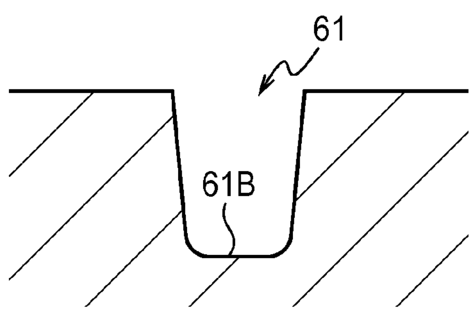


FIG.4C

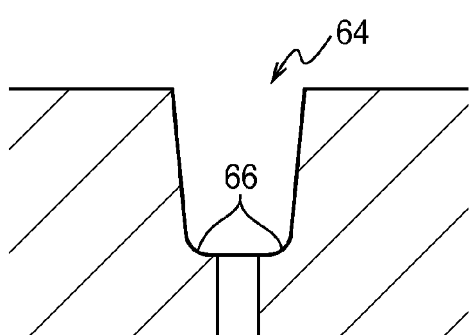


FIG.5

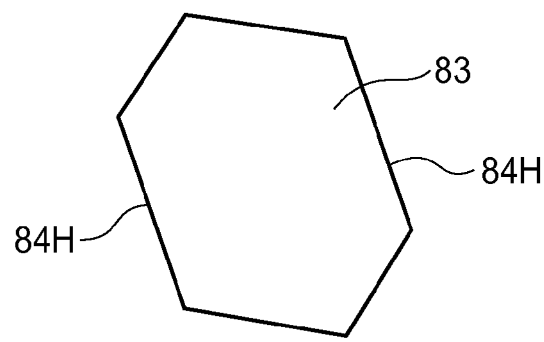


FIG.6

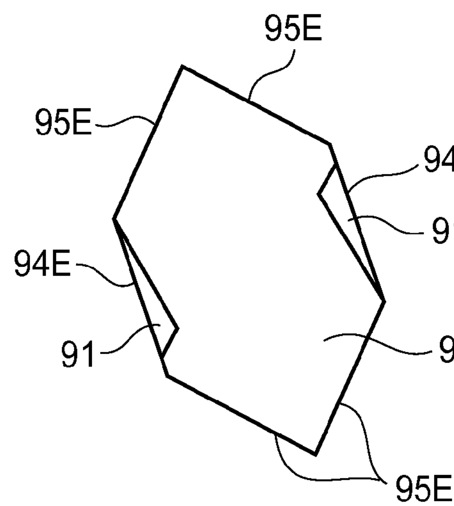


FIG.7

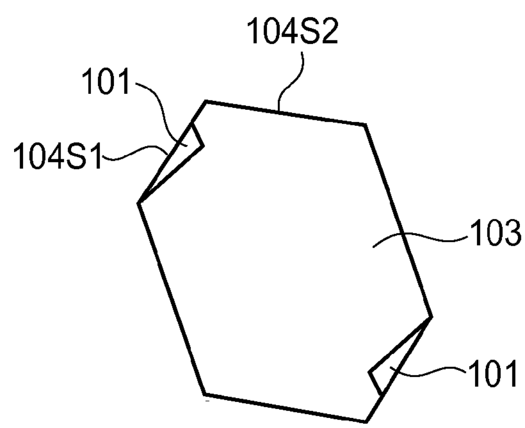


FIG.8
RELATED ART

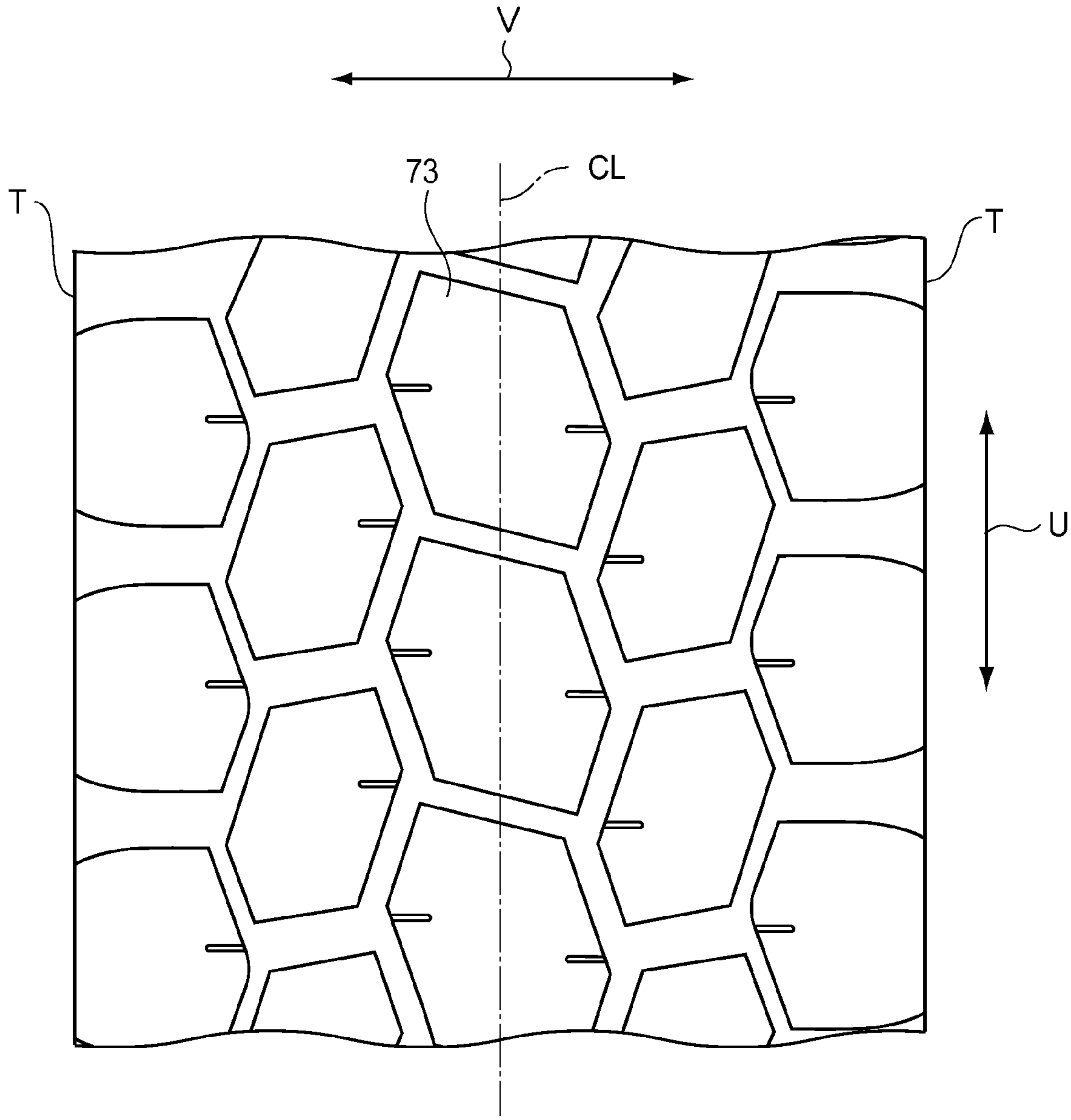
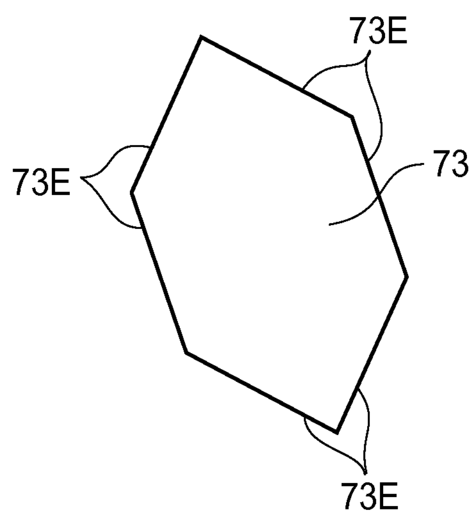


FIG.9

RELATED ART



TIRE WITH TREAD HAVING BLOCKS HAVING CUTOUT PORTIONS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a National Stage of International Application No. PCT/JP2010/050992, filed on Jan. 26, 2009, which claims priority from Japanese Patent Application No. 2009-014394, filed on Jan. 26, 2009, the contents of all of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

The present invention relates to a tire formed with a tread section having block rows extending along the tire circumferential direction formed by circumferential direction grooves and lateral grooves.

BACKGROUND ART

Uneven wear can occur with a tire, depending in particular on the conditions of use (see, for example, Patent Document 1 regarding a pattern for suppressing uneven wear). Uneven wear here refers to blocks wearing non-uniformly. When such uneven wear occurs then this readily causes a dramatic decrease in the wear life of the tire.

Block profiles configured to give uniform wearing energy across the surface of the blocks have already been considered as countermeasures to such uneven wear. The wearing energy on the block surface is represented by the product of the shearing force acting at the block surface (namely the product of the contact pressure and the coefficient of friction) with the sliding length of the block surface on the road surface.

In order to secure stability a design has also been put forward that increases the edge component of blocks to enhance wet weather performance (braking performance on a wet road).

Patent Document 1: 2007-145209

DISCLOSURE OF INVENTION

Technical Problem

However, when striving to make the wearing energy uniform to suppress uneven wear it becomes difficult to secure the edge components of blocks, and difficult to achieve sufficient wet weather performance. However, when the tread rubber volume is increased in order to raise the wear life resistance to heat falls, resulting in heat related damage tending to increase and tending to lead to wear life falling. An increase in tread rubber volume also has the adverse effect of increasing manufacturing cost.

The present invention is made in consideration of the above circumstances and is directed towards provision of a tire with raised wet weather performance while maintaining resistance to uneven wear performance, without entailing an increase in tread rubber volume.

Solution to Problem

A first aspect of the present invention is a tire including plural blocks formed in a tread section by circumferential direction grooves and lateral grooves, wherein each of the blocks is a polygonal shape viewed from the tread face side including long sides adjacent to the circumferential direction grooves and short sides, and a cutout portion is formed on at least one of the long sides of the blocks.

Reference here to a polygonal shape includes shapes with beveled corner portions. Reference to a cutout portion includes indented portions of rounded form and gentle indented profiles.

In order to secure wet weather performance there is a need to the secure edge component of blocks, as explained above. In the first aspect of the present invention the edge component is increased by provision of the cutout portions to the blocks.

The blocks are polygonal shaped when viewed from the tread face side, including long sides adjacent to the circumferential direction grooves and short sides, and a cutout portion is formed on the side of at least one of the long sides of the blocks. Namely, cutout portions are formed on the side of the long sides rather than on the side of the short sides. This accordingly results in block rigidity being less readily reduced than when cutout portions are formed on the side of the short sides of blocks, or when cutout portions are formed to blocks having uniform lengths for each of the sides. Consequently, resistance to uneven wear performance is secured since there is little localized flow of block rubber and the wearing energy applied to the block tread face side becomes more uniform. A further effect is obtained of distributing side force that is a cause of uneven wear.

The edge component is increased by the cutout portions and so wet weather performance can be enhanced.

A second aspect of the present invention is a tire wherein the long sides are formed together with the cutout portions on both the tire width direction sides of the block.

The effects of the first aspect of the invention can be enhanced by adopting such a configuration.

A third aspect of the present invention is a tire wherein: the external profile of each of the cutout portions when seen in plan view is a triangular shape including a bottom side formed by at least a portion of the long side and a long sloping side and a short sloping side having different lengths from each other; and along one tire circumferential direction the disposed sequence of the long sloping side and the short sloping side is different on one tire width direction side of the block to on the other width direction side of the block.

A consideration when forming cutout portion there that the probability of cracks developing increases with the number of corner portions (bend portions) of the indented shapes configuring the cutout portions. Therefore forming the cutout portions with a triangular shaped external profile viewed in plan view, as in the third aspect of the present invention, results in cutout portions with only a single corner portion, reducing the possibility of cracks developing.

Furthermore, the external profile described above is a triangular shape including the bottom side formed by at least a portion of the long side and the long sloping side and the short sloping side having different lengths from each other, and along one tire circumferential direction the disposed sequence of the long sloping side and the short sloping side is different on one tire width direction side of the block to on the other width direction side of the block. By adopting such a configuration, change in length reduction of the tire width direction separation distance on the block face due to forming the cutout portions is readily suppressed over the entire length of the cutout portions. Consequently, suppressing localized weakening in the block rigidity from occurring in the tire circumferential direction due to forming the cutout portions.

A fourth aspect of the present invention is a tire, wherein: the shape of the cutout portions is symmetrical about a point at the center of the block; and the block is formed with a block traversing groove that is open on the two tire width direction sides of the block further to side of the long sloping side than an intersection point between the short sloping side and the long sloping side.

In the fourth aspect of the present invention the shape of the cutout portions is symmetrical about a point at the center of the block, enhancing suppression of localized weakening from occurring in block rigidity in the tire circumferential direction due to forming the cutout portions.

When the external profile of the cutout portions in plan view has a groove open to the short sloping side from the sloping sides of the triangular shape then the rigidity of the block portions adjacent to the opening is readily reduced, with a tendency for cracks to occur. However in the fourth aspect of the present invention, the block traversing grooves that cut across the blocks do not open onto the short sloping sides, and so the rigidity of the block portions forming openings is not readily reduced.

A fifth aspect of the present invention is a tire wherein the length ratio of the short side to the long side is in the range of 25 to 85%.

Less than 25% results in uneven wear readily occurring at the block side on the short side even though the cutout portions are not formed to the side of the block short sides. However, when greater than 85% it becomes difficult to achieve sufficient suppression effect of uneven wear on the block sides of the long sides formed with the cutout portions.

A sixth aspect of the present invention is a tire wherein a tire width direction separation distance between one side width direction end of the corresponding cutout portion and the other side width direction end of the cutout portion is in the range of 7 to 12% of the tire width direction separation distance between one side width direction end of the block and the other side width direction end of the block.

Wet weather performance is readily reduced at less than 7%. However the wear life of the tire is readily reduced at greater than 12%.

A seventh aspect of the present invention is a tire wherein: the depth of the cutout portion at the deepest location from the tread face is in the range of 20 to 40% of the depth of the circumferential direction groove adjacent to the cutout portion; and the wall face of the cutout portion slopes downwards from the tread face.

Wet weather performance is readily reduced when shallower than 20%. However, the wearing energy acting on the block tread face tends to be uneven when deeper than 40%, making it difficult to achieve sufficient resistance to uneven wear performance. The depth of the deepest location from the tread face of the cutout portion is more preferably in the range of the 25% to 35% of the depth of the circumferential direction groove adjacent to the cutout portion.

The wall face of the cutout portion also slopes down from the tread face and so a reduction in the block rigidity due to forming the cutout portions can be further suppressed.

Advantageous Effects of Invention

The present invention enables a tire to be achieved with enhanced wet weather performance while maintaining resistance to uneven wear performance, without entailing an increase in tread rubber volume.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a radial direction cross-section of a pneumatic radial tire according to an exemplary embodiment of the present invention.

FIG. **2** is a plan view illustrating a tread section of a pneumatic radial tire according to an exemplary embodiment of the present invention.

FIG. **3** is an explanatory diagram illustrating the external profile of a block configuring a center block row in a pneumatic radial tire according to the exemplary embodiment of the present invention, as viewed from the tread face side.

FIG. **4**A is a plan view of a tread section of a modified example of a pneumatic radial tire according to the exemplary embodiment of the present invention.

FIG. **4**B is a lateral cross-section taken on arrow **4**B-**4**B of FIG. **4**A.

FIG. **4**C is a lateral cross-section taken on arrow **4**C-**4**C of FIG. **4**A.

FIG. **5** is an explanatory diagram illustrating the external profile of a block configuring a center block row in a Comparative Example Tire **1** employed in Test Examples, as viewed from the tread face side.

FIG. **6** is an explanatory diagram illustrating the external profile of a block configuring a center block row in a Comparative Example Tire **2** employed in Test Examples, as viewed from the tread face side.

FIG. **7** is an explanatory diagram illustrating the external profile of a block configuring a center block row in a Comparative Example Tire **3** employed in Test Examples, as viewed from the tread face side.

FIG. **8** is a plan view illustrating a tread section of a Conventional Example Tire employed in Test Examples.

FIG. **9** is an explanatory diagram illustrating the external profile of a block configuring a center block row in a Conventional Example Tire employed in Test Examples, as viewed from the tread face side.

DESCRIPTION OF EMBODIMENTS

Explanation follows regarding an exemplary embodiment of the present invention, with an example of a pneumatic radial tire as an exemplary embodiment. As shown in FIG. **1**, a pneumatic radial tire **10** according to an exemplary embodiment of the present invention is a tire for a truck or bus, and is equipped with a carcass **12**. The carcass **12** includes folded over portions **12**E at the two edge portions where the carcass **12** is folded around bead cores **11**C of bead sections **11**.

Belt layers **14** are buried at the tire radial direction outside of a crown section **12**C of the carcass **12**. A tread section **18** disposed with grooves is formed at the tire radial direction outside of the belt layers **14** (see also FIG. **2**).

As shown in FIG. **2**, four main grooves **20**L, **20**R, **22**L, **22**R are formed in the tread section **18** along the circumferential direction at both sides of a tire center line CL. The tread section **18** is formed by the presence of the 4 main grooves into 5 block rows running along the tire circumferential direction U. The 5 block rows configure: a center block row **30** through which the tire center line CL passes; second block rows **40**L, **40**R adjacent on the left and right sides of the center block row **30**; and shoulder block rows **50**L, **50**R positioned at the outside in the tire width direction V of the second block rows **40**L, **40**R.

The four main grooves are configured by main grooves **20**L, **20**R positioned on the center side (the tire center line side), and main grooves **22**L, **22**R positioned on the shoulder side. The four main grooves **20**L, **20**R, **22**L, **22**R extend in zigzag shapes along the tire circumferential direction. Extending in zigzag shapes along the tire circumferential direction refers to extending along the tire circumferential direction with groove portions that are inclined to the tire circumferential direction and repeatedly fold back on each other so as to then be inclined in a different direction.

Lug grooves **32** are formed in the center block row **30** so as to connect together locations where the separation distance between the main groove **20**L and the main groove **20**R is smaller due to the zigzag extending shape of the main grooves **20**L, **20**R.

Similarly, lug grooves **42**L are formed in the second block row **40**L at locations where the separation distance between the main groove **20**L and the main groove **22**L is smaller due to the zigzag extending shape of the main grooves **20**L, **22**L. Lug groove **42**R are also formed in the second block row **40**R at locations where the separation distance between the main groove **20**R and the main groove **22**R is smaller due to the zigzag extending shape of the main grooves **20**R, **22**R.

Configuration with main grooves (circumferential direction grooves) and lug groove is such a pattern results in blocks **33** configuring the center block row **30** that are hexagonally shaped when viewed from the tread face side, with a tire width direction length (the tire width direction cross-sectional length) that increases from both tire circumferential direction ends of the blocks **33** to a block central portion. Each of the sides forming the hexagonal shape is set by the separation distance between the main groove **20**L and the main groove **20**R and by the dimensions of the zigzag shape of the main grooves **20**L, **20**R, so as to form long sides **34**H on the two tire width direction ends of each of the blocks **33** and to form short sides **34S1**, **34S2** on the other sides. In the present exemplary embodiment, as shown in FIG. **2** and FIG. **3**, the short sides **34S1** are shorter in length than the short sides **34S2**. The short sides **34S1** are adjacent to either the main groove **20**L or the main groove **20**R. The length ratio of the shorter short sides **34S1** with respect to the long sides **34**H is in the range of 25 to 85%, namely, as shown in FIG. **3**, the short side length dS1 of the short side **34S1** is in the range of 25 to 85% of the long side length dH.

Cutout portions **21** are formed in the sides of the long sides **34**H at both sides of the blocks **33** in the tire width direction. A tire width direction separation distance **21**M between one side tire width direction end **21**P of the cutout portion **21** and the other side tire width direction end **21**Q of the cutout portion **21** is in the range of 7 to 12% of the tire width direction separation distance **33**M between one side tire width direction end **33**P of the block **33** and the other side tire width direction end **33**Q of the block **33**.

The depth from the tread face at the deepest location of the cutout portions **21** is in the range of 20 to 40% of the depth of the main groove adjacent to the cutout portions **21** (the main groove **20**L or the main groove **20**R). A wall face **21**F of the cutout portions **21** slopes downwards from the tread face (namely slopes downwards from the tread face). Configuration may, however, be made such that the depth of the cutout portions **21** is the same as that of the main grooves, and the wall face is not sloped in this manner.

Blocks **43** configuring the second block row **40**L are also, similarly to the blocks **33**, hexagonal shaped when viewed from the tread face side with the tire width direction length increasing from both tire circumferential direction ends of the blocks **43** to a block central portion. Each of the sides forming the hexagonal shape is set by the separation distance between the main groove **20**L and the main groove **22**L, and the dimensions of the zigzag shape of the main grooves **20**L, **22**L, so as to form long sides **44**H on the two tire width direction sides of each of the blocks **43**, and short sides **44S1**, **44S2** on the other sides. In the present exemplary embodiment, as shown in FIG. **2**, the short sides **44S1** are shorter in length than the short sides **44S2**. The short sides **44S1** are adjacent to either the main groove **20**L or the main groove **22**L. The length ratio of the shorter short sides **44S1** to the long sides **44**H is in the range of 25 to 85%.

Cutout portions **41** are formed at both tire width direction sides of the blocks **43** on the long sides **44**H side. A tire width direction separation distance **41**M between one side tire width direction end **41**P of the cutout portion **41** and the other tire width direction side end **41**Q of the cutout portion **41** is in the range of 7 to 12% of the tire width direction separation distance **43**M between one side tire width direction end **43**P of the block **43** and the other side tire width direction end **43**Q of the block **43**.

The depth of the cutout portions **41** is in the range of 20 to 40% of the depth of the main groove adjacent to the cutout portions **41** (the main groove **20**L or the main groove **22**L). A wall face **41**F of the cutout portion **41** slopes downwards from the tread face (namely slopes downwards from the tread face).

The second block row **40**R is also configured similarly to the second block row **40**L.

The shape of the cutout portions **21** are symmetrical about a point at the block center. The external profile of each of the cutout portions **21** in plan view is a triangular shape, formed with a bottom side **21**A formed by a portion of the long side **34**H, and two sides of different lengths from each other, a long sloping side **21**B and a short sloping side **21**C. There is accordingly a single corner portion (bend portion) **21**D formed in plan view with an indented shape in the cutout portion **21**. Similar applies to the cutout portions **41** formed in the blocks **43**.

Lug grooves **52**L are formed in the shoulder block row **50**L, are connected to the main groove **22**L and extend further to the tire width direction outside than a tread edge T. Lug grooves **52**R are also formed in the shoulder block row **50**R, are connected to the main groove **22**R and extend further to the tire width direction outside than a tread edge T. Reference to the tread edges here indicates the tire width direction outermost ground contact portion when the pneumatic radial tire is mounted to a standard rim, as defined in the JATMA YEAR BOOK (2008 edition, Japan Automobile Tire Manufacturers Association standards), inflated to an internal pressure of 100% of the pressure (maximum pressure) corresponding to maximum load (load shown in bold type in the internal pressure-load chart) in the JATMA YEAR BOOK for the applicable size/ply rating, and applied with the maximum load. Where the location of use or manufacturing location uses TRA standards or ETRTO standards then these respective standards are applied.

Fine grooves (water grooves) **36** are formed in the center block row **30** and are connected to the main grooves **20**L, **20**R. Each of the fine grooves **36** is shaped like a crank, with the locations of the end portions of the lug grooves **42**L, **42**R located at the end positions of the fine groove **36**.

Fine grooves (water grooves) **46** are also formed in the second block rows **40**L, **40**R, each in the shape of a crank and connecting the main grooves **20**L, **22**L. The location of the end portion of the lug groove **52**L of the shoulder block row **50**L and the location of the end portion of the lug groove **32** of the center block row **30** are located at the two end positions of each of the fine grooves **46** of the second block row **40**L. The location of the end portion of the lug grooves **52**R of the shoulder block row **50**R and the location of the end portion of the lug groove **32** of the center block row **30** are similarly located at the two end positions of each of the fine grooves **46** of the second block row **40**R.

Accordingly in the present exemplary embodiment the fine grooves **36** are open at the tire width direction sides of the blocks **33** further towards the long sloping side than the corner portion **21**D. Similar applies to the fine grooves **46**.

Fine grooves **51** are also formed in the shoulder block row **50**L so as to be connected to the main groove **22**L, extend in the tire width direction and be closed off inside the blocks. The location of the end portion of the lug groove **42**L of the second block row **40**L is located at the position extended out from each of the fine grooves **51**. Fine grooves **51** are similarly also formed in the shoulder block row **50**R.

As explained above, in the present exemplary embodiment the edge component of the blocks **33**, **43** is increased and wet weather performance is enhanced by forming the cutout portions **21** in the sides of the blocks **33** on the long sides and forming the cutout portions **41** in the sides of the blocks **43** on the long sides.

When viewed from the tread face side both the blocks **33** and the blocks **43** are formed in hexagonal shapes with a width direction length that increases from the two tire circumferential direction sides of the block to a block central portion, with the hexagonal shapes formed with both long sides (the long sides **34**H or the long sides **44**H) and short sides. The cutout portions **21**, **41** are also both formed so as to be adjacent to the main grooves that are adjacent to the long sides of the blocks (the main grooves **20**L, **20**R, **22**L or **22**R). Namely, the cutout portions **21**, **41** are formed so as to encroach into the blocks from the side of the long side and not from the side of the short side. Accordingly, even though the cutout portions are formed the block rigidity is less readily lowered in comparison to cases in which the cutout portions of the blocks are adjacent to the lug grooves **32**, **42**L, **42**R, or case in which the cutout portions are formed in at least one side of the sides of blocks having sides that are all of the same length as each other. Accordingly, sufficient resistance to uneven wear is maintained, due to there being little block rubber localized flow, and abrasion energy applied from the tread face side of the blocks **33** and the blocks **43** being easily made uniform. In addition an effect of dissipating side force that cause uneven abrasion is obtained.

The edge component of the blocks **33** and the blocks **43** is increased by the presence of the cutout portions **21**, **41** and sufficient wet weather performance can be maintained.

The blocks **33** and the blocks **43** have a length ratio of the short side to the long side in the range of 25 to 85%. Accordingly uneven wear on the side of the blocks on the long sides formed with the cutout portions **21**, **41** can be sufficiently suppressed and uneven wear on the side of the blocks on the short sides can also be sufficiently suppressed.

The tire width direction separation distance **21**M between the one side tire width direction end **21**P of the cutout portion **21** and the other end tire width direction side **21**Q of the cutout portion **21** is in the range of 7 to 12% of the tire width direction separation distance **33**M between the one side tire width direction end **33**P of the block **33** and the other side tire width direction end **33**Q of the block **33**. Similar applies to the cutout portions **41**. Accordingly sufficient enhancement of wet weather performance can obtained, and a deterioration in the wear life of the tire can also be sufficiently suppressed.

The depth of the cutout portions **21**, **41** is in the range of 20 to 40% of the depth of respective adjacent main groove, hence achieving a configuration readily able to secure resistance to uneven wear as well as enhancing wet weather performance.

The depth of the cutout portions **21** is in the range of 20 to 40% of the depth of the respective adjacent groove to the cutout portions **21**. The wall face **21**F of each of the cutout portions **21** slopes downwards from the tread face (namely slopes downwards form the tread face). Namely the block rigidity in the cutout portions **21** is raised at the block skirt sides, further enabling suppression of a fall in block rigidity due to the presence of the cutout portions **21**, **41**.

The external profile of the cutout portions **21** is a triangular shape in plan view, with a bottom side **21**A formed by a portion of the long side **34**H, and with two sides of different lengths from each other, the long sloping side **21**B and the short sloping side **21**C. There is a single corner portion (bend portion) **21**D formed in an indented shape in the cutout portions **21** in plan view.

The eternal profile in plan view of the cutout portions **21** formed at the two tire width direction sides of the blocks **33** is such that the cutout portions **21** are formed in the tire width direction sides so as to face different directions to each other (namely, along one of the tire circumferential directions the disposed sequence of the long sloping side **21**B and the short sloping side **21**C is the opposite at one tire width direction side of the block **33** to at the other tire width direction side of the block **33**). Accordingly, change in length reduction of the tire width direction separation distance on the block face due to forming the cutout portions **21** is readily suppressed over the entire length of the cutout portions **21**. Forming the shape of the cutout portions **21** in the present exemplary embodiment so as to be symmetrical about a point at the center of the blocks **33** is optimal from the perspective of suppressing the change referred to above. For example, as shown in FIG. **3**, the tire width direction separation distances dJ, dK, dL between the cutout portions are substantially the same as each other even though their locations along the tire circumferential direction differ. The length reduction in the tire width direction separation distance of the block surface due to forming the cutout portions **21** is substantially the same length across the entire length of the cutout portions **21**. Accordingly, the block rigidity in the tire circumferential direction can be sufficiently suppressed from localized weakening even though the cutout portions **21** are formed. When cutout portions are formed in blocks the probability of cracks developing can be thought of as increasing by the increase in the number of corner portions configuring the cutout portions. Accordingly, configuring the cutout portions **21** with a triangular external profile in plan view as in the present exemplary embodiment results in there being only a single corner portion **21**D as an indentation formed in the cutout portions **21**, accordingly lowering the possibility of cracks developing.

Similar applies to the cutout portions **41**.

The fine grooves (water grooves) **36** are formed in each of the blocks **33** of the center block row **30**, and the fine grooves (water grooves) **46** are formed in each of the blocks **43** of the second block rows **40**L, **40**R. The wet weather performance and traction performance is accordingly enhanced.

The fine grooves **36** are also formed in the blocks **33** such that they cut across the blocks **33** and are open at both tire width direction sides. The fine grooves **36** are open further to the side of the long sloping side than the corner portion **21**D. The fine grooves **46** are formed similarly to the blocks **43**. The rigidity of the block portion forming an opening would readily decrease were a groove to open on the short sloping side **21**C, this being the shorter of the sloping sides in the triangular external profile of the cutout portions **21** in plan view, leading to a tendency for cracks to develop.

According, even though the fine grooves **36**, **46** are formed cutting across the blocks **33**, **43** and open to the two tire width direction sides in the present exemplary embodiment, the rigidity of the block portions forming the openings of the fine grooves **36**, **46** is not readily decreased.

As shown in FIG. **4**A, configuration may be made with the center block row **30** formed with lug grooves **62** to which tie-bars **61** have been formed. The tie-bars are groove portions formed with a raised bottom portion **61**B. The circumferential direction rigidity of the blocks **33** can be raised by forming the tie-bars **61**, enabling uneven wear to be further suppressed. In such cases, as shown in FIG. **4**C, configuration may be made with the groove portions **64** adjacent to the two ends of the tie-bars **61** formed with shallow bottom portions **66** that are the same depth as that of the tie-bars **61**, and with deep bottom portions **68** that are deeper than the tie-bars **61** at the groove center side.

Test Examples

In order to confirm the effect of the present invention, the present inventor prepares an example of the pneumatic radial tire **10** of the exemplary embodiment (referred to as Example Tire), an example of a conventional pneumatic radial tire (referred to below as Conventional Tire Example), and 3 examples of pneumatic radial tires for comparison (referred to below as Comparative Example Tires 1 to 3), and perform an evaluation of performance according to performance testing of abrasion resistance performance and braking performance. The size of all of the tires in the tests is “11R/22.5”.

The Conventional Example Tire and the Comparative Examples Tires of 1 to 3 are tires that have different block shapes compared to the Example Tire. The Conventional Example Tire and the Comparative Examples Tires 1 to 3 are not formed with the fine grooves (water grooves) **36** or the tie-bars **61** described in the above exemplary embodiment. Accordingly, in order to align test conditions the Example Tire is also not formed with the fine grooves **36** or the tie-bars **61**.

width direction sides of the tread face. Namely, it is a tire that differs from the Conventional Example Tire by being formed with the cutout portions **91** on the two tire width direction sides.

The Comparative Example Tire **3**, as shown in FIG. **7**, is a tire disposed with a row of blocks **103** formed on the two tire width direction sides with cutout portions **101** at the side of the short sides **104S1**, these being the shorter of the short sides **104S1**, **104S2**, in place of the cutout portions **21** formed in the blocks **33** of the Example Tire.

The Example Tire has a tire width direction separation distance **21**M of the cutout portions **21** set at 10.7% of the tire width direction separation distance **33**M of the blocks **33**, and has a depth from the tread face of the cutout portions **21** of the deepest location set at 30% of the depth of the respective main groove (**20**L, **20**R) adjacent to the cutout portions **21**.

The following tests are performed regarding resistance to uneven wear performance. With respect to the vehicle, front mounting of a 2D4 is used for each vehicle. Namely a vehicle with two drive axles is employed, with test tires disposed on both sides of the front axle, and conventional tires employed on both sides of the rear axle (same as the Conventional Example Tires). Accordingly, each vehicle is mounted with 2 test tires and 2 conventional tires.

Each vehicle is run for 150,000 km. Tire rotation is performed in running every 10% of the running distance (namely at every 15,000 km of running). After completing running for 150,000 km the block volume is measured for each of the test tires, and the amount of uneven wear determined from the reduction amount of block volume.

A relative evaluation index is computed for the other tires with respect to an evaluation value for resistance to uneven wear performance of the Conventional Example Tire set at 100. The evaluation results are shown in Table 1. The greater the evaluation index in the evaluation results in Table 1 the higher the performance, namely the greater value indicates excellent resistance to uneven wear performance.

TABLE 1

	Example Tire 1	Conventional Example Tire	Comparative Example Tire 1	Comparative Example Tire 2	Comparative Example Tire 3
Wet Weather Performance	110	100	100	110	110
Resistance to Uneven Wear Performance	99	100	100	93	90

The Conventional Example Tire is, as shown in FIGS. **8** and **9**, a tire formed with hexagonal shaped blocks **73** with sides **73**E on the tread face that are all the same length as each other. Accordingly, there are no cutout portions formed in the blocks.

The Comparative Example Tire **1**, as shown in FIG. **5**, is a tire with hexagonal shaped blocks **83** having a long side **84**H on each side of the tread face in the tire width direction, and short faces on the other sides, with no cutout portions formed. Namely, it is a tire that differs from the Example Tire by not being formed with the cutout portions **21**.

The Comparative Example Tire **2**, as shown in FIG. **6**, is a tire formed with hexagonal shaped blocks **93** with tread face sides **94**E that are all the same length as each other, however the tire has cutout portions **91** formed at both tire

It can be seen from Table 1 that the Example Tire and the Comparative Example Tire **1** have equivalent resistance to uneven wear performance to the Conventional Example Tire.

Braking performance testing is performed as set out below.

A 2D4 is employed as the vehicle. All of the tires are inflated to an internal pressure of 775 kPa. All of the tires are applied with a load of 3000 kg.

The braking distance is measured on a test course when brakes are applied at a running speed of 80 km/h. The test is performed 4 times for each of the tires, and the average braking distance determined.

A relative evaluation index is computed for the other tires with respect to an evaluation value for braking performance of the Conventional Example Tire set at 100. The evaluation results are combined in Table 1. In the evaluation results of Table 1 the higher the evaluation index the higher the performance, namely a higher value indicates excellent braking performance.

It can be seen from Table 1 that the Example Tire and the Comparative Example Tires 2 and 3 result in greatly superior braking performance compared to the Conventional Example Tire.

Consequently, it can be seen in the current Test Examples that the Example Tire has equivalent resistance to uneven wear performance to the Conventional Example Tire, and greatly superior braking performance to that of the Conventional Example Tire.

While embodiments of the present invention have been explained by way of the above exemplary embodiments these are merely examples of embodiments, and various modifications can be made within a scope not departing from the spirit. Obviously the scope of rights of the present invention is also not limited by the exemplary embodiments above.

The invention claimed is:

1. A tire comprising:

a plurality of blocks formed in a tread section by circumferential direction grooves and lateral grooves, wherein:

each of the blocks is a polygonal shape viewed from the tread face side, the polygonal shape comprising long sides, adjacent to the circumferential direction grooves, and short sides, and wherein a cutout portion is formed on the side of at least one of the long sides of the blocks,

the circumferential direction grooves include a pair of center grooves, and a center block row of the blocks is disposed between the center grooves on an equatorial plane of the tire,

the center grooves extend in a zigzag shape, and

center lug grooves connect together locations where a separation distance between the center grooves is smallest, the center lug grooves being formed at the center block row,

wherein the long sides are formed together with the cutout portions on both the tire width direction sides of the block,

wherein:

the external profile of each of the cutout portions, when seen in plan view, is a triangular shape including a bottom side formed by at least a portion of the long side, and a long sloping side and a short sloping side having different lengths from each other; and

along one tire circumferential direction, the disposed sequence of the long sloping side and the short sloping side is different on one tire width direction side of the block to on the other width direction side of the block,

wherein:

the shape of the cutout portions is symmetrical about a point at the center of the block; and

the block comprises a block traversing groove that is open at both tire width direction sides of the block at a first position and a second position, respectively, each of the first and second positions corresponds to a vertex formed by the bottom side and the long sloping side of the cutout portion having a triangular shape,

wherein:

the plurality of blocks comprises a shoulder block row including shoulder blocks, a shoulder block of the shoulder blocks comprising a fine groove connected to an outer groove of the circumferential direction grooves at one end and the other end of the fine groove terminating within the shoulder block, and

wherein a tire width direction separation distance between one side width direction end of the cutout portion and the other side width direction end of the cutout portion is in the range of 7 to 12% of the tire width direction separation distance between one side width direction end of the corresponding block and the other side width direction end of the block.

2. The tire of claim **1**, wherein:

the length ratio of the short side to the long side is in the range of 25 to 85%.

3. The tire of claim **1**, wherein:

the depth of the cutout portion at the deepest location from the tread face is in the range of 20 to 40% of the depth of the circumferential direction groove adjacent to the cutout portion; and

the wall face of the cutout portion slopes downwards from the tread face.

4. The tire of claim **1**, wherein the plurality of blocks further comprises a second block row provided between the center block row and the shoulder block row, the second block row including second blocks,

wherein each second block comprises a second block traversing groove, and

wherein each end of the block traversing groove and the second block traversing groove is connected to one of the circumferential direction grooves.

5. The tire of claim **4**, wherein the shoulder block row comprises a shoulder lug groove provided between adjacent shoulder blocks, and

wherein a width of the shoulder lug groove increases from an inner end of the lug groove toward an outer end of the lug groove with respect to the equatorial plane of the tire.

6. The tire of claim **5**, wherein the second block row comprises second lug grooves connecting together locations where a separation distance between the center grooves the center groove and the outer groove is the smallest,

wherein each end of the block traversing groove is located at an end portion of the second lug grooves,

wherein each end of the second block traversing groove is located at an end portion of one of the center lug grooves and the shoulder lug groove, and

wherein the one end of the fine groove is located at an end portion of the second lug grooves.

7. The tire of claim **1**, wherein the shoulder block row comprises a shoulder lug groove provided between adjacent shoulder blocks, and

wherein a width of the shoulder lug groove is wider than widths of the circumferential direction grooves.

8. The tire of claim **1**, wherein the plurality of blocks further comprises a second block row provided between the center block row and the shoulder block row,

wherein the second block row comprises second lug grooves connecting together locations where a separation distance between the center grooves the center groove and the outer groove is the smallest, and

wherein widths of the second lug grooves are wider than widths of the circumferential direction grooves.

9. The tire of claim **1**, wherein widths of the center lug grooves are narrower than widths of second lug grooves of a second block row provided between the center block rows and the shoulder block row, and wherein the widths of the center lug grooves are narrower than widths of shoulder lug grooves of the shoulder block row.

10. The tire of claim **1**, wherein each corner of the blocks has an obtuse angle.

11. The tire of claim **1**, wherein the following relationship is satisfied:

$A>B>C$, where

A represents widths of shoulder lug grooves of the shoulder block row;

B represents widths of second lug grooves of a second block row provided between the center block rows and the shoulder block row, and

C represents widths of the center lug grooves.

* * * * *